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Hugh Butler Reservoir, Frontier and Red Willow Counties, Nebraska

Pacific Northwest Environmental Research Lab, Corvallis, Oreg

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

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REPORT
ON
HUGH BUTLER RESERVOIR
FRONTIER AND RED WILLOW COUNTIES
NEBRASKA
EPA REGION VII
WORKING PAPER No. 557

WITH THE COOPERATION OF THE
NEBRASKA DEPARTMENT OF ENVIRONMENTAL CONTROL
AND THE
NEBRASKA NATIONAL GUARD
AUGUST, 1976

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Nebraska Department of Environmental Control for professional involvement, to the Nebraska National Guard for conducting the tributary sampling phase of the Survey, and to those wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

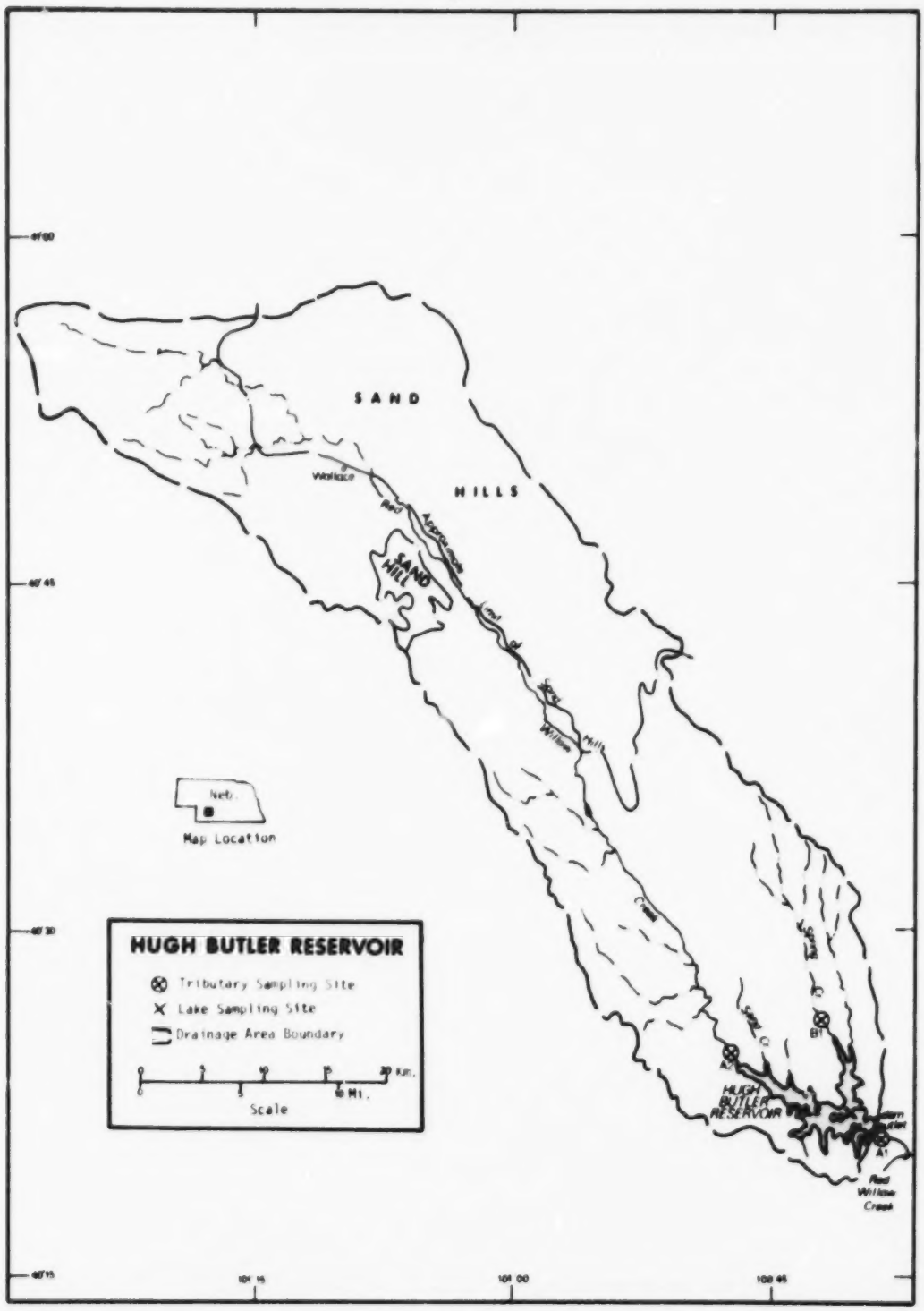
The staff of the Water Pollution Control Division, Department of Environmental Control, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

Major General Francis L. Winner, the Adjutant General of Nebraska, and Project Officer Colonel Burl M. Johnson, who directed the volunteer efforts of the Nebraska National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STATE OF NEBRASKA

RESERVOIR NAME	COUNTY
Branched Oak	Lancaster
Harlan County	Harlan
Harry D. Strunk	Frontier
Hugh Butler	Frontier, Red Willow
Johnson	Dawson, Gosper
McConaughy	Keith
Pawnee	Lancaster
Sherman	Sherman
Swanson	Hitchcock


SAND
HILLS
Wallace
SAND HILL
Map Location
HUGH BUTLER RESERVOIR
Tributary Sampling Site
Lake Sampling Site
Drainage Area Boundary
Scale
HUGH BUTLER RESERVOIR
Red Willow Creek

HUGH BUTLER RESERVOIR

STORET NO. 3104

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Hugh Butler Reservoir is eutrophic. It ranked sixth in overall trophic quality when the nine Nebraska reservoirs sampled in 1974 were compared using a combination of six parameters*. Three of the reservoirs had less median total phosphorus, four had less median dissolved orthophosphorus, one had less and two had the same median inorganic nitrogen, five had less mean chlorophyll a, and five had greater mean Secchi disc transparency. Marked depression of dissolved oxygen with depth occurred at sampling station 1 in July.

Survey limnologists observed rooted aquatic plants near both sampling stations in September.

B. Rate-Limiting Nutrient:

Because of nutrient changes in the samples, the algal assay results are not considered representative of conditions in the reservoir at the times the samples were collected (04/16/74 and 09/27/74).

The reservoir data indicate nitrogen limitation in April and September.

C. Nutrient Controllability:

1. Point sources--No known municipal or industrial point

* See Appendix A.

sources impacted Hugh Butler Reservoir during the sampling year. Septic tanks serving shoreline dwellings and campgrounds were estimated to have contributed 0.1% of the total phosphorus load to the reservoir, but a shoreline survey would be needed to determine the significance of these sources.

The present phosphorus loading of 1.61 $g/m^2/yr$ is over three times that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11).

2. Non-point sources--Non-point phosphorus contributions accounted for essentially all of the inputs to the reservoir during the sampling year. Red Willow Creek contributed 61.5% of the total, and the ungaged drainage area contributed an estimated 37.3%. Apparently, any significant reduction in the phosphorus loading to the reservoir is dependent on improved land-use practices in the drainage.

The phosphorus export rate of Red Willow Creek was 13 kg/km^2 during the sampling year (see page 10). This rate is about one-half that of Medicine Creek, a tributary of nearby Harry D. Strunk Reservoir*, but is about six times the rate of the Republican River at the inlet of Swanson Reservoir**.

* Working Paper No. 556.
** Working Paper No. 562.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 6.59 kilometers^2.
2. Mean depth: 5.9 meters.
3. Maximum depth: 17.4 meters.
4. Volume: 38.881 x 10^6 m^3.
5. Mean hydraulic retention time: 1.2 years (based on outflow).

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Red Willow Creek	518.0	0.84
Spring Creek	98.4	0.16
Minor tributaries & immediate drainage -	205.8	0.35
Totals	822.2	1.35

2. Outlet -

Irrigation withdrawal	0.0	0.50**
Red Willow Creek	828.8	0.56
Total	828.8***	1.06

C. Precipitation****:

1. Year of sampling: 47.6 centimeters.
2. Mean annual: 52.8 centimeters.

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† Table of metric conversions--Appendix B.
†† Hartung, 1974; Adamovich, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Alridge, 1976.
*** Includes area of reservoir.
**** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Hugh Butler Reservoir was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Samples for physical and chemical parameters were collected from a number of depths at two stations on the reservoir in April and three stations in July and September (see map, page v). During each visit, a single depth-integrated (4.6 m or near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the first and third visits, a single 18.9-liter depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 12.2 meters at station 1, 7.6 meters at station 2, and 7.6 meters at station 3.

The sampling results are presented in full in Appendix D and are summarized in the following table (the July nutrient samples were not preserved properly and were not analyzed).

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR HUGH BUTLER (RED WILLOW)
STORET CODE 3104

	1ST SAMPLING (4/16/74) 2 SITES			2ND SAMPLING (7/ 1/74) 3 SITES			3RD SAMPLING (9/27/74) 3 SITES		
PARAMETER	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN	RANGE	MEAN	MEDIAN
TEMP (C)	8.1 - 8.5	8.3	8.2	17.0 - 25.5	22.3	23.0	16.4 - 17.0	16.8	16.8
DISS OXY (MG/L)	9.2 - 10.4	10.1	10.3	0.6 - 8.2	5.9	7.2	7.2 - 8.6	7.8	7.8
CNDCTVY (MCROMO)	155. - 325.	252.	271.	485. - 578.	528.	525.	234. - 392.	272.	237.
PH (STAND UNITS)	8.4 - 8.5	8.4	8.4	7.9 - 8.5	8.3	8.4	8.1 - 8.3	8.2	8.2
TOT ALK (MG/L)	214. - 240.	229.	232.	****** -**********			234. - 282.	256.	254.
TOT P (MG/L)	0.025 - 0.264	0.074	0.055	****** -**********			0.002 - 0.094	0.065	0.064
ORTHO P (MG/L)	0.004 - 0.009	0.007	0.007	****** -**********			0.008 - 0.027	0.020	0.019
NO2+NO3 (MG/L)	0.020 - 0.040	0.032	0.030	****** -**********			0.050 - 0.140	0.108	0.130
AMMONIA (MG/L)	0.020 - 0.030	0.025	0.025	****** -**********			0.030 - 0.070	0.045	0.040
KJEL N (MG/L)	0.300 - 1.200	0.712	0.700	****** -**********			0.000 - 1.200	0.685	0.600
INORG N (MG/L)	0.040 - 0.070	0.057	0.055	****** -**********			0.090 - 0.210	0.153	0.160
TOTAL N (MG/L)	0.330 - 1.230	0.745	0.735	****** -**********			0.720 - 1.320	0.793	0.740
CHLRPYL A (UG/L)	20.8 - 38.5	29.6	29.6	2.3 - 10.6	5.2	2.6	7.8 - 25.3	19.4	25.0
SECCHI (METERS)	0.5 - 0.9	0.7	0.7	0.4 - 1.7	1.2	1.5	0.4 - 0.5	0.4	0.5

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/16/74	1. *Asterionella sp.*	14,842
	2. Centric diatoms	7,574
	3. Flagellates	4,031
	4. *Ankistrodesmus sp.*	2,871
	5. *Dactylococcopsis sp.*	428
	Other genera	1,160
	Total	30,906
07/01/74	1. *Ankistrodesmus sp.*	805
	2. *Cryptomonas sp.*	805
	3. *Carteria sp.*	725
	4. *Dactylococcopsis sp.*	322
	5. Flagellates	322
	Other genera	1,690
	Total	4,669
09/27/74	1. Centric diatoms	1,280
	2. Flagellates	411
	3. *Cryptomonas sp.*	228
	4. *Stephanodiscus sp.*	183
	5. *Oocystis sp.*	137
	Other genera	548
	Total	2,787

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
04/16/74	1	20.8
	2	38.5
	3	-
07/01/74	1	10.6
	2	2.3
	3	2.6
09/27/74	1	25.0
	2	7.8
	3	25.3

TECHNICAL REPORT DATA (Please read Instructions on the reverse before completing)	
1. REPORT NO.	2.
3. RECIPIENT'S ACCESSION NO.	
4. TITLE AND SUBTITLE Report on Hugh Butler Reservoir, Frontier and Red Willow Counties, Nebraska	5. REPORT DATE Prepared August 1976
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)	8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 557
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330	10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460	13. TYPE OF REPORT AND PERIOD COVERED Final - 1974 14. SPONSORING AGENCY CODE
15. SUPPLEMENTARY NOTES Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114	

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS		
a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C
18. DISTRIBUTION STATEMENT Release unlimited	19. SECURITY CLASS (This Report)	21. NO. OF PAGES 36 37
	20. SECURITY CLASS (This page)	22. PRICE PRICES SUBJECT TO CHANGE 4.00/3.00

EPA Form 2220-1 (9-73)

C. Limiting Nutrient Study:

Because of significant changes in nutrient concentrations in the assay samples between the times of collection and the beginning of the assays, the results are not representative of conditions in the reservoir at the times the samples were taken (04/16/74 and 09/27/74).

The reservoir data indicate nitrogen was limiting at stations 1 and 2 in April and at all three stations in September; i.e., the mean inorganic nitrogen/orthophosphorus ratios were 10/1 or less, and nitrogen limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Nebraska National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v). Sampling was begun in August, 1974, and was completed in July, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Nebraska District Office of the U.S. Geological Survey for the tributary sites nearest the reservoir.

In this report, nutrient loads at station A-2 were calculated using mean annual concentrations and mean annual flows. Nutrient loads at station A-1 were calculated by adding the flow measured at station A-1 of Red Willow Creek to the amount of water withdrawn for irrigation, in m^3/sec, and multiplying the sum by the mean nutrient concentrations at A-1.

Spring Creek was not sampled during the Survey year because of lack of flow. The normalized flow of this stream was added to the normalized "ZZ" flow to estimate loads.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the mean nutrient concentrations in Red Willow Creek at station A-2 and the mean ZZ flow (plus Spring Creek flow) in m^3/sec.

No known municipal or industrial point sources impacted Hugh Butler Reservoir during the sampling year.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/yr	% of total
a. Tributaries (non-point load) -		
Red Willow Creek	6,515	61.5
b. Minor tributaries & immediate drainage (non-point load) -	3,955	37.3
c. Known municipal STP's - None	-	-
d. Septic tanks* -	10	0.1
e. Known industrial - None	-	-
f. Direct precipitation** -	115	1.1
Total	10,595	100.0

2. Outputs -

Lake outlet - Red Willow Creek Irrigation withdrawal } 1,940

3. Net annual P accumulation - 8,655 kg.

* Estimate based on 12 shoreline dwellings and 3 campgrounds; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Red Willow Creek	50,360	57.0
b. Minor tributaries & immediate drainage (non-point load) -	30,575	34.6
c. Known municipal STP's - None	-	-
d. Septic tanks* -	340	0.4
e. Known industrial - None	-	-
f. Direct precipitation** -	7,115	8.0
Total	88,390	100.0

2. Outputs -

Lake outlet - Red Willow Creek Irrigation withdrawal	48,705

3. Net annual N accumulation - 39,685 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km²/yr	kg N/km²/yr
Red Willow Creek	13	97

* Estimate based on 12 shoreline dwellings and 3 campgrounds; see Working Paper No. 175.
** See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	1.61	1.31	13.4	6.0

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Hugh Butler Reservoir:

"Dangerous" (eutrophic loading)	0.44
"Permissible" (oligotrophic loading)	0.22

V. LITERATURE REVIEWED

Adamovich, Ted, 1975. Personal communication (reservoir morphometry). NE Dept. of Environ. Contr., Lincoln.

Alridge, Ray, 1976. Personal communication (estimate of evaporation loss and irrigation withdrawal from Hugh Butler Reservoir). Bureau of Reclamation, McCook.

Hartung, Ray, 1974. Personal communication (reservoir morphometry). NE Dept. of Environ. Contr., Lincoln.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	SSD-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
3101	BRANCHED OAK	0.044	0.070	456.444	17.033	9.400	0.013
3102	HARLAN COUNTY RESERVOIR	0.112	0.365	476.111	27.822	12.200	0.061
3103	HARRY D. STRUNK (MEDICIN	0.064	0.480	470.500	14.367	14.200	0.009
3104	HUGH BUTLER (RED WILLOW	0.061	0.090	468.875	16.612	14.400	0.014
3105	JOHNSON RESERVOIR	0.075	0.340	477.667	26.133	8.600	0.009
3106	LAKE MCCONAUGHY	0.027	0.585	409.555	8.644	11.400	0.004
3107	PAWNEE LAKE	0.060	0.175	453.000	15.367	8.800	0.020
3108	SHERMAN COUNTY RESERVOIR	0.067	0.090	451.167	6.717	11.800	0.050
3110	SWANSON RESERVOIR	0.067	0.090	466.333	14.450	11.000	0.016

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
3101	BRANCHED OAK	88 (7)	100 (8)	63 (5)	25 (2)	75 (6)	63 (5)	414
3102	HARLAN COUNTY RESERVOIR	0 (0)	25 (2)	13 (1)	0 (0)	25 (2)	0 (0)	63
3103	HARRY D. STRUNK (MEDICIN	50 (4)	13 (1)	25 (2)	75 (6)	13 (1)	81 (6)	257
3104	HUGH BUTLER (RED WILLOW)	63 (5)	75 (5)	38 (3)	38 (3)	0 (0)	50 (4)	264
3105	JOHNSON RESERVOIR	13 (1)	38 (3)	0 (0)	13 (1)	100 (8)	81 (6)	245
3106	LAKE MCCONAUGHY	100 (8)	0 (0)	100 (8)	88 (7)	50 (4)	100 (8)	438
3107	PAWNEE LAKE	75 (6)	50 (4)	75 (6)	50 (4)	88 (7)	25 (2)	363
3108	SHERMAN COUNTY RESERVOIR	38 (3)	75 (5)	88 (7)	100 (8)	38 (3)	13 (1)	352
3110	SWANSON RESERVOIR	25 (2)	75 (5)	50 (4)	63 (5)	63 (5)	38 (3)	314

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	3106	LAKE MCCONAUGHY	438
2	3101	BRANCHED OAK	414
3	3107	PAWNEE LAKE	363
4	3108	SHERMAN COUNTY RESERVOIR	352
5	3110	SWANSON RESERVOIR	314
6	3104	HUGH BUTLER (RED WILLOW)	264
7	3103	HARRY D. STRUNK (MEDICIN	257
8	3105	JOHNSON RESERVOIR	245
9	3102	HARLAN COUNTY RESERVOIR	63

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR NEBRASKA 12/23/75

LAKE CODE 3104 HUGH BUTLER LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 802.9

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3104A1	828.8	0.17	0.22	0.21	0.28	0.48	0.96	1.78	1.61	0.42	0.24	0.11	0.13	0.56
3104A2	518.0	0.68	0.91	1.08	0.99	0.99	1.22	0.85	0.57	0.71	0.65	0.79	0.71	0.84
3104B1	98.4	0.13	0.17	0.20	0.19	0.19	0.23	0.16	0.11	0.14	0.12	0.15	0.14	0.16
3104ZZ	212.4	0.28	0.37	0.44	0.41	0.41	0.50	0.35	0.23	0.29	0.27	0.33	0.29	0.35

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 802.9
SUM OF SUB-DRAINAGE AREAS = 828.8
TOTAL FLOW IN = 16.22
TOTAL FLOW OUT = 6.63

NOTE *** TOTAL & ZZ DR. AREAS DIRECTLY CONTRIBUTING. 730 SQ. MI. TOTAL AREA.

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
3104A1	8	74	1.93	25	2.66				
	9	74	0.40	8	0.59				
	10	74	0.13	6	0.13				
	11	74	0.13	16	0.13				
	12	74	0.11	7	0.11				
	1	75	0.12	5	0.11				
	2	75	0.13	8	0.13				
	3	75	0.13	22	0.13				
	4	75	0.12	19	0.15				
	5	75	0.41	4	0.13				
	6	75	0.51	7	0.10				
	7	75	2.80						
3104A2	8	74	0.35	25	0.31				
	9	74	0.39	8	0.40				
	10	74	0.53	6	0.45				
	11	74	0.71	16	0.71				
	12	74	0.60	7	0.59				
	1	75	0.75	5	0.57				
	2	75	0.64	8	0.65				
	3	75	1.09	22	1.10				
	4	75	1.03	19	1.02				
	5	75	0.77	4	0.71				
	6	75	1.68	7	0.62				
	7	75	1.04						

TRIBUTARY FLOW INFORMATION FOR NEBRASKA 12/23/75

LAKE CODE 3104 HUGH BUTLER LAKE

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
310481	8	74	0.0	25	0.0				
	9	74	0.0	8	0.0				
	10	74	0.0	6	0.0				
	11	74	0.0	16	0.0				
	12	74	0.0	7	0.0				
	1	75	0.0	5	0.0				
	2	75	0.0	8	0.0				
	3	75	0.0	22	0.0				
	4	75	0.0	19	0.0				
	5	75	0.0	4	0.0				
	6	75	0.0	7	0.0				
	7	75	0.0						
3104ZZ	8	74	0.14	25	0.13				
	9	74	0.16	8	0.16				
	10	74	0.22	6	0.19				
	11	74	0.29	16	0.29				
	12	74	0.25	7	0.24				
	1	75	0.31	5	0.23				
	2	75	0.26	8	0.27				
	3	75	0.44	22	0.45				
	4	75	0.42	19	0.42				
	5	75	0.32	4	0.29				
	6	75	0.69	7	0.25				
	7	75	0.42						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/12/23

310401
40 21 23.0 100 40 13.0
HUGH BUTLER (RED WILLOW)
31 NEBRASKA

11EPALES 2111202
3 0047 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/16	10 00	0000	8.4		36	299	8.50	240	0.030	0.600	0.040	0.009
	10 00	0005	8.2	10.4		171	8.45	238	0.020	0.400	0.030	0.005
	10 00	0015	8.1	10.2		255	8.45	238	0.020	0.300	0.030	0.004
	10 00	0040	8.1	10.4		302	8.40	236	0.020	0.400	0.020	0.005
74/07/01	14 45	0000	23.0	7.2	60	535	8.40					
	14 45	0005	22.9	7.0		525	8.40					
	14 45	0015	21.4	4.8		578	8.20					
	14 45	0020	20.8	1.8		508	8.00					
	14 45	0030	17.8	0.6		493	7.90					
	14 45	0040	17.0	3.0		485	7.90					
74/09/27	14 25	0000	16.9	7.4	19	237	8.21	242	0.070	0.600	0.140	0.024
	14 25	0005	16.8	7.4		235	8.22	266	0.060	0.600	0.140	0.016
	14 25	0015	16.8	7.2		236	8.21	236	0.040	0.600	0.140	0.027
	14 25	0025	16.8	7.6		236	8.22	268	0.050	0.600	0.140	0.017
	14 25	0036	16.8	7.4		236	8.22	254	0.050	0.600	0.140	0.016

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/16	10 00	0000	0.032	20.8	
	10 00	0005	0.025		
	10 00	0015	0.030		
	10 00	0040	0.056		
74/07/01	14 45	0000		10.6	
74/09/27	14 25	0000	0.059	25.8	
	14 25	0002			1.0
	14 25	0005	0.064		
	14 25	0015	0.059		
	14 25	0025	0.064		
	14 25	0036	0.061		

STORET RETRIEVAL DATE 75/12/23

310402
40 22 18.0 100 43 19.0
HUGH BUTLER (RED WILLOW)
31 NEBRASKA

11EPALES 2111202
3 0030 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/16	13 55	0000	8.5		20	155	8.40	218	0.030	1.200	0.030	0.008
	13 55	0005	8.4	10.4		219	8.40	214	0.020	0.800	0.030	0.007
	13 55	0015	8.3	9.8		287	8.40	220	0.030	0.900	0.040	0.007
	13 55	0025	8.1	9.2		325	8.40	222	0.030	1.100	0.040	0.008
74/07/01	15 20	0000	25.5	7.6	17	553	8.50					
	15 20	0005	25.5	7.8		552	8.50					
	15 20	0010	25.4	8.0		550	8.50					
74/09/27	15 00	0000	16.4	8.2	14	241	8.33	246	0.040	0.800	0.060	0.008
	15 00	0005	16.4	8.0		392	8.35	240	0.040	0.700	0.050	0.024
	15 00	0010	16.4	8.2		235	8.33	254	0.040	0.700	0.050	0.027
	15 00	0016	16.4	8.4		234	8.35	234	0.040	0.700	0.050	0.025

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/16	13 55	0000	0.054	38.5	
	13 55	0005	0.059		
	13 55	0015	0.069		
	13 55	0025	0.264		
74/07/01	15 20	0000		2.3	
74/09/27	15 00	0000	0.078	7.8	
	15 00	0005	0.088		
	15 00	0010	0.083		
	15 00	0016	0.094		

STORET RETRIEVAL DATE 75/12/23

310403
40 22 09.0 100 40 26.0
HUGH BUTLER (RED WILLOW)
31 NEBRASKA

11EPALES 2111202
3 0029 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/07/01	15 50	0000	23.6	8.2	65	527	8.50					
	15 50	0005	23.6	8.0		524	8.50					
	15 50	0015	23.5	8.2		521	8.40					
	15 50	0025	21.1	4.8		510	8.20					
74/09/27	14 00	0000	17.0	8.6	18	389	8.07	278	0.040	0.600	0.120	0.012
	14 00	0005	17.0	7.8		375	8.17	264	0.040	1.200	0.120	0.014
	14 00	0015	17.0	7.6		249	8.15	266	0.040	0.600	0.130	0.027
	14 00	0025	16.9	7.8		243	8.11	282	0.030	0.600	0.130	0.019

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/07/01	15 50	0000		2.6	
74/09/27	14 00	0000	0.002	25.3	
	14 00	0003			1.0
	14 00	0005	0.056		
	14 00	0015	0.066		
	14 00	0025	0.065		

APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/01/27

3104A1
40 20 50.0 100 38 35.0
RED WILLOW CREEK
31063 7.5 RD WILLOW DM
O/HUGH BUTLER LAKE
BRDG ON US RT 83 2.8 M SE OF RED WIL DAM
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/08/25	08 55		0.048	0.500	0.025	0.020	0.065
74/09/08	08 55		0.288	0.500	0.025	0.030	0.050
74/10/06	08 55		0.600	0.900	0.035	0.025	0.025
74/11/16	08 55		0.800	1.000	0.035	0.035	0.070
74/12/07	08 55		0.750	0.400	0.015	0.035	0.050
75/01/05	08 55		0.800	3.400	0.160	0.040	0.050
75/02/08	08 55		0.795	0.400	0.068	0.048	0.060
75/03/22	08 55		0.655	0.450	0.015	0.040	0.050
75/04/19	08 55		0.480	0.700	0.075	0.030	0.050
75/05/04	09 55		0.480	0.550	0.080	0.020	0.040
75/06/07	08 55		0.630	0.900	0.090	0.050	0.130

STORET RETRIEVAL DATE 76/01/27

3104A2
40 24 42.0 100 47 15.0
RED WILLOW CREEK
31 7.5 BURGER CAN E
T/HUGH BUTLER LAKE
BRDG ON SEC RD 4 M NE OF BEEBE LNDG STRP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/08/25	10 00		0.600	1.600	0.015	0.080	0.290
74/09/08	10 00		0.519	1.300	0.010	0.055	0.270
74/10/06	10 00		0.296	0.800	0.060	0.025	0.150
74/11/16	10 00		0.730	0.900	0.050	0.060	0.140
74/12/07	10 00		0.770	0.900	0.045	0.060	0.190
75/01/05	10 00		0.960	1.000	0.104	0.065	0.120
75/02/08	10 00		0.900	1.350	0.084	0.068	0.275
75/03/22	10 00		0.534	1.200	0.040	0.069	0.350
75/04/19	10 00		0.575	1.350	0.055	0.100	0.110
75/05/04	10 00		0.750	1.300	0.165	0.130	0.310
75/06/07	10 00		0.380	2.200	0.055	0.095	0.500